

METHOD OF PROVIDING A COMPOSITION FOR AN EYE

BACKGROUND OF THE INVENTION

The present invention relates to the use of photopolymerizable compositions for preparing an intraocular lens filling material which is used during an operation where an intraocular lens shell is inserted. The treatment of cataracts (grey cataract) and other eye complaints frequently requires removal of the natural lens of the eye. Since the implantation of the first artificial intraocular lens (IOL) of polymethylmethacrylate (PMMA) (H. Ridley, 1948), this operation has become routine in many ophthalmological clinics.

Depending upon the location of insertion, a distinction is made between three IOL types: Anterior chamber lenses, intrapupillary lenses and posterior chamber lenses. The lenses consist of a lens body and a haptic which ensures the fixing of the lens. The lens body is usually made from PMMA homopolymers, more rarely from copolymers such as PMMA-ethylene glycol dimethacrylate, PMMA-hydroxyethyl methacrylate (HEMA) or PMMA-vinyl pyrrolidone, and in more recent times from silicone elastomers. In many cases a UV absorber is added to protect the retina from UV light, as is also done by the natural lens. The haptic may be very differently shaped and usually consists of polypropylene, more rarely known of PMMA.

A disadvantage common to all these systems is that they all employ relatively large rigid bodies so that for the implantation a relatively large incision through the endothelium of the cornea is necessary. This surgical intervention leads not only to damage and loss of part of the unregeneratable cornea endothelial cells; in addition, with the size of the incision the danger of formation of a corneal edema increases, as does that of astigmatism arising. Another disadvantage is that each IOL must be adapted separately to the specific requirements and it is consequently necessary to produce and store a great number of types having different thicknesses.

EP-A-0308130 discloses deformable resilient intraocular lenses which are made from a mixture of monofunctional acrylic or methacrylic acid esters with addition of small amounts of difunctional acrylic or methacrylic acid esters. The production of the lenses is carried out in a conventional manner outside the body and as a result adjusting the lens thickness and the refraction values is not possible during the operation.

DE-C-3702625 discloses intraocular lenses for implantation after an extracapsular cataract which consists of an elastic silicones shell which is provided with a transparent filling of curable material. The curable material is to consist of "transparent acryl" to which a photoinitiator is added. No particulars on the nature of the monomers or photoinitiators used are to be found in this patent specification.

It is an object of the present invention to provide a photopolymerizable mass which during the operation on the eye can either be directly introduced into the capsule bag or can be introduced into the eye into a previously implanted resilient envelope. Since via the injection point, after curing the material is in direct contact with the eye interior, it is essential that the intraocular-lens filling material be at the most negligibly toxic and for no appreciable amounts to be extractable out of the polymerized material.

This object, and other objects and advantages of the present invention, will appear more clearly from the following specification and examples.

SUMMARY OF THE INVENTION

The method of the present invention is characterized primarily by providing a photopolymerizable composition that contains the following components:

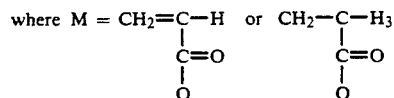
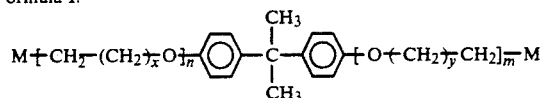
- 90-99.99% by weight, preferably 94-99.799% by weight, of at least one at least difunctional acrylic and/or methacrylic acid ester,
- 0.01-5% by weight, preferably 0.1-2% by weight, of at least one photoinitiator which is activatable with light in the wavelength range 400-500 nm,
- 0-9.98% by weight, preferably 0.001-2% by weight, of a UV-absorber which can absorb light of wavelengths <400 nm, and
- 0-9.98% by weight, preferably 0.1-2% by weight, of other auxiliary substances, such as dyes or activators for the photoinitiator, for example tertiary amines,

the quantity particulars referring in each case to the total mass.

The at least difunctional acrylic or methacrylic acid esters preferably have a molecular weight >310 and are preferably the diacrylic or dimethacrylic acid esters of at least difunctional polyhydroxy compounds with aliphatic and/or aromatic skeleton having at least six chain links, the skeleton consisting of the atoms carbon, oxygen, nitrogen.

Well-suited are for example the diacrylic or dimethacrylic acid esters of bisphenols, for example bisphenol A or the bishydroxypolyalkoxy bisphenol A derivatives lengthened with ethylene oxide or propylene oxide. Preferred here are the bisphenol A types lengthened on both sides with 1 to 5 and in particular 1-3 ethylene oxide units. Particularly preferred are compounds of the formula I.

Formula I:



and n, m=1-5, in particular 1-3, and x, y=1, 2, 3, in particular 1.

Also well-suited are the bisacrylic acid or bismethacrylic acid esters of cycloaliphatic diols, in particular the cycloaliphatic diols lengthened with ethylene oxide and propylene oxide. Particularly suitable are the diols of the bis-(hydroxymethyl)-tricyclo[5.2.1.0^{2,6}]decane lengthened with ethylene oxide. Preferably, each OH group is lengthened with 1-5 and in particular with 1-3 ethylene oxide units.

Well-suited at least difunctional acrylic acid or methacrylic acid esters are also the reaction products of at least two parts hydroxyalkyl acrylate or hydroxyalkyl methacrylate with at least difunctional polyisocyanates having an aliphatic or aromatic skeleton. Particularly preferred are the reaction products of 2 parts hydroxyalkyl methacrylates, for example hydroxy propylmetha-